Advanced Reusable Space Transportation Technologies Research NRA 8-21/Cycle 2

Offerors' Briefing

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Purpose of Briefing

- **Small Payload Launch System Program Overview**
  - Program — Sherry Buschmann
  - Vehicle Concepts — David Anderson
  - Technologies — Shayne Swint
- **Describe NASA Research Announcement 8-21 Cycle 2**
  - Overview — Sherry Buschmann
  - Procurement — Mark Stiles
- **Allow for Questions and Answers**

Contents of NRA Take Precedence over Briefing

Objectives and Customers

Goal

- Enable a reusable, rapid turn-around, launch vehicle system that delivers small science and technology payloads (200 lbs.) to low earth orbit for $1.0M through the development and demonstration of innovative concepts and technologies

Program Elements

- User Workshop and Requirements Definition
- Launch Service Contract Solicitation
- Technology Development and Demonstration
- Vehicle Concept Definition and Development
- Flight Testing through Future-X Program

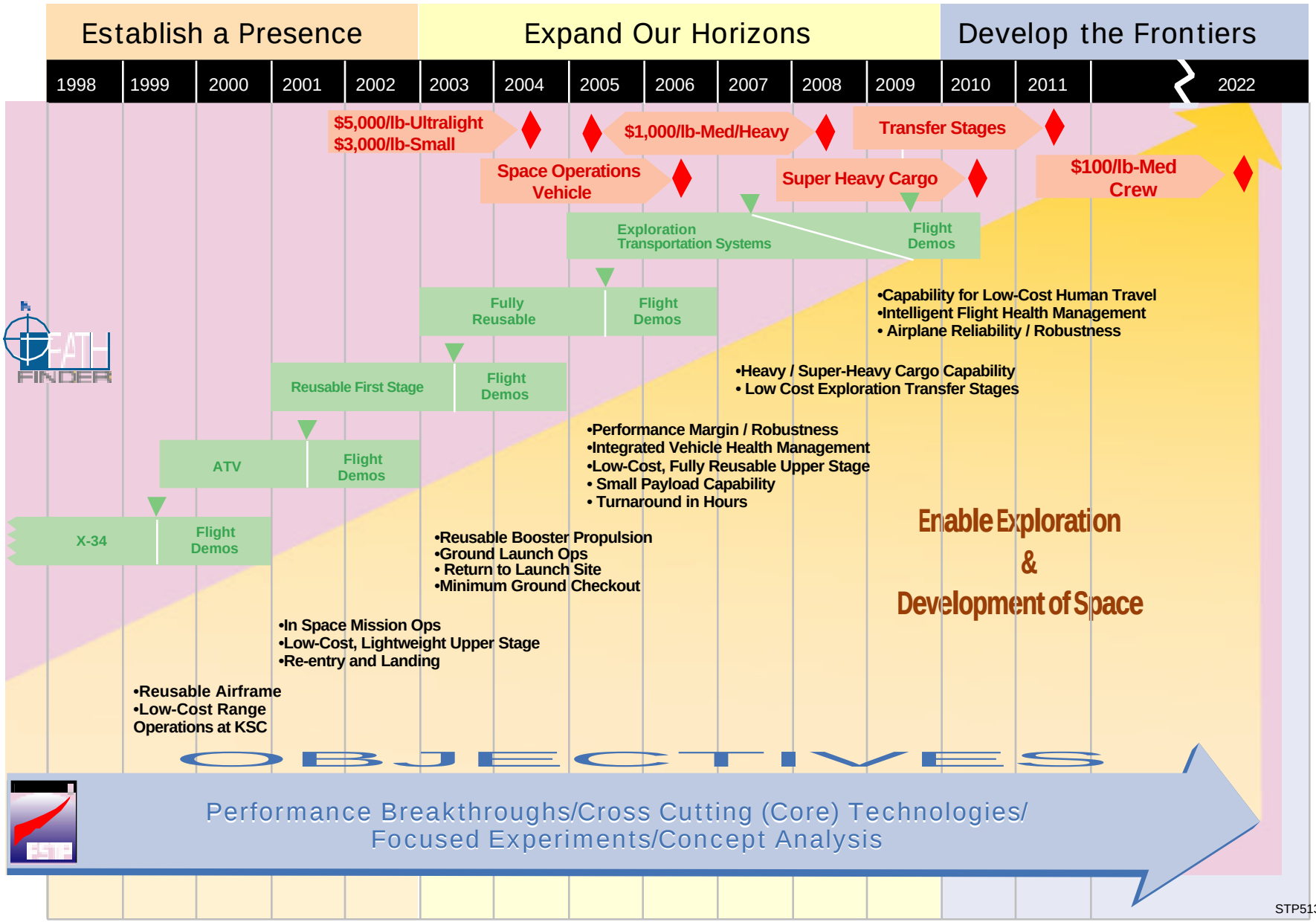
Program Customers

- Science (Universities, OSS, OES, OLMSA) and Technology (OASTT, HEDS)
- Technology Transfer to Industry

End Products

- Development of cutting edge technologies that enable dramatic reduction in the cost of access to space for small payloads
- Successful flight testing of Bantam class RLV through the Future-X Flight Demonstrator Program

Level II Roadmap



Vehicle Concepts Overview

Vehicle Concept Definition

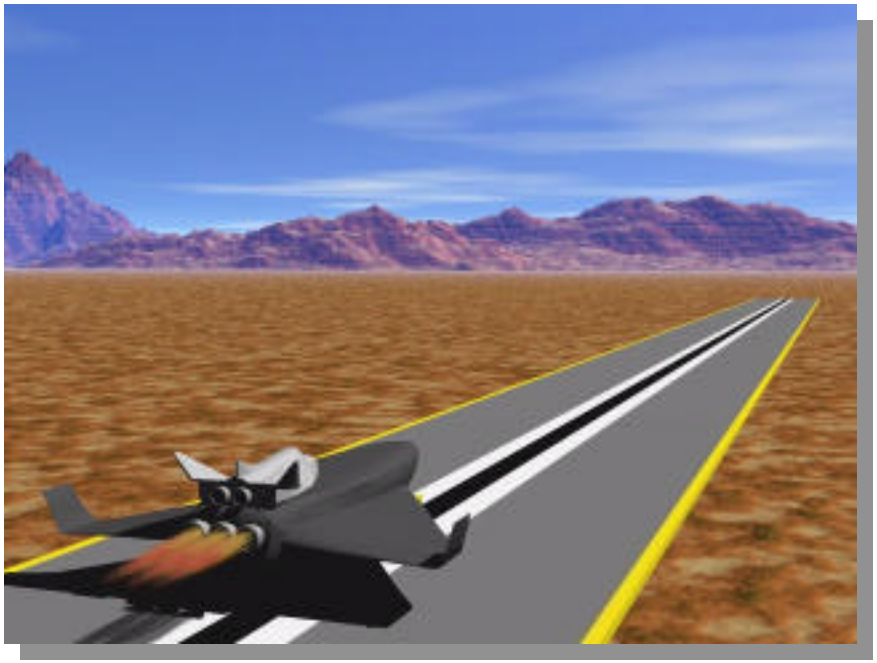
- Vehicle Definition studies are designed to:
  - Define small payload vehicle “design space”
  - Identify technology areas which need to be developed
  - Identify operations issues associated with small payload reusable launch systems
    - Ground Operations/Turnaround
    - Flight Operations
    - Mission/Preflight Planning
  - Trade Space Identified
    - Rocket or Rocket-Based Combined Cycle (RBCC) First Stage
    - High Energy or Low-Energy Upper Stage Options
    - Candidate Structural and TPS Materials
    - Propulsion Options
    - Launch Assist Options

Vehicle Concept Definition

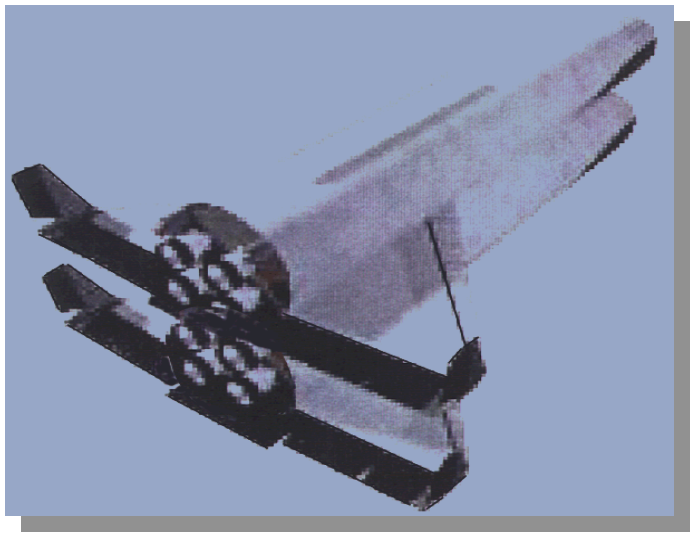
- X-34 Being Evaluated as Testbed for Low Cost Technologies
  - Allows Key Operational Technologies to be Assessed
    - IVHM
    - Operations/Turnaround
    - Mission Planning
    - Postflight Safing
  - Provides Platform for Test of Low Cost Technologies
    - Lightweight Structures/Materials
    - Thermal Protection System Elements
    - Sensors/Instrumentation
    - Propulsion System Elements

Small Payload Launch System Concepts

Rocket-Powered, Two-Stage, Horizontal Liftoff w/ Launch Assist, Horizontal Landing



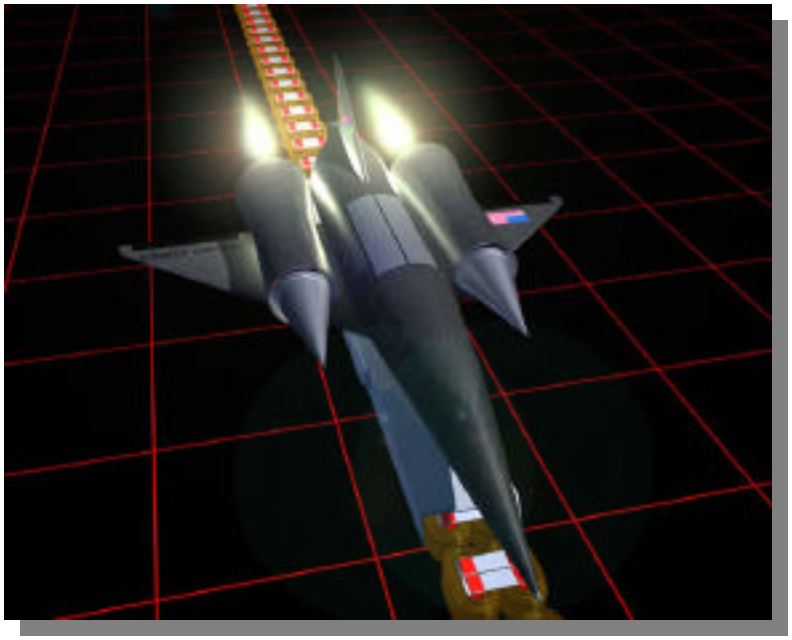
Small Payload Launch System Concepts



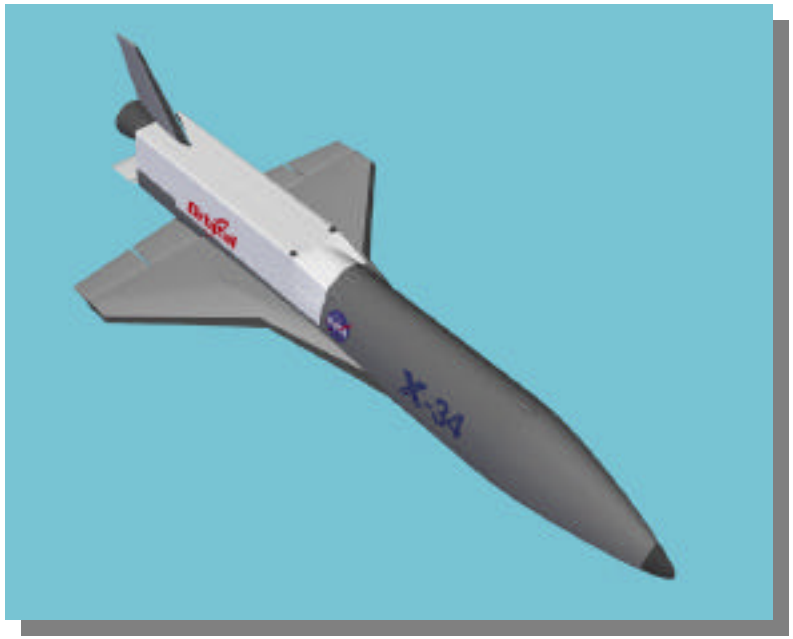
Rocket-Powered, Two-Stage, Vertical Liftoff w/ Launch Assist, Horizontal Landing (Bimese)

Small Payload Launch System Concepts

Rocket-Based Combined Cycle Two-Stage, Horizontal Takeoff/ Horizontal Landing



X-34 Technology Demonstrator



Current Technology Content Overview

Current Technology Tasks

Vehicle Systems (TA1)

Power Technologies

- **High Energy Density Electrochemical Capacitors**
  - High Energy capacitors Sized to handle peak engine and vehicle power requirements to greatly reduce battery and system wire weight of the transportation system.
- **Lithium-Based Rechargeable Batteries**
  - Offer size and weight advantages over currently available battery systems with increased reliability.
- **Modular High Voltage High Current Switchgear**
  - Develop modular system breadboard to integrate multiple switches, bus feeds, data, and control functions into a modular chassis.

Operations Technologies

- **Passive Coherent Location**
  - System uses existing commercial UHF and VHF Broadcasting transmitters as the transmitting component for Vehicle tracking.
- **Automated Umbilical Mating Tech**
  - System with connect, disconnect, and re-connect capability would eliminate the need for high percentage of touch-labor required by current vehicle launch systems at T-0.

Current Technology Tasks

Vehicle Systems (TA1-Continued)

Avionics and IVHM

- **High Density Structural Sensors**
  - Develop multiplexing technology for passive monitoring acoustical emission sensors addressing the unique high speed switching requirements, high data rates, and asynchronous data characteristics.
- **Smart Sensor Development**
  - Miniaturized leak sensor electronics will achieve a ten-fold reduction in size and weight of the sensor head.
- **Robust GN&C**
  - Includes guidance, navigation and control hardware, algorithms and software that will maximize vehicle availability, minimize mission specific changes, and increase prelaunch vehicle autonomy while minimizing costs by leveraging commercial and DOD expenditures.
- **Modular Avionics**
  - Develop configurable avionics unit which can perform processing, data management, and signal conditioning functions, in conjunction with like units throughout the vehicle.
- **IVHM Diagnostic S/W**
  - Architecture uses information from multiple heterogeneous data sources to reason globally about vehicle health through extension of technology developed for Deep Space One.

Current Technology Tasks

Vehicle Systems (TA1-Continued)

Structures and Materials

- **Integrated MPS Cryotank System**
  - Development of structures with common bulkheads and conformal tankage utilizing PMC's and Aerogel insulation, and lightweight joint technology.
- **Ultra High Temperature PMCs**
  - Use of high temp. PMCs in propulsion and airframe systems may reduce component weight by up to 20%.
- **Adhesives & Sealants**
  - Hot-melt adhesives enable assembly of large-scale structures avoiding need for large-scale autoclaves to cure large bonded structure and greatly simplified repair.
- **Non-autoclave Auto. Fab. PMCs]**
  - E-beam curing can reduce tooling requirements and cure times resulting in a 25%-60% component cost savings. This task explores capability to perform E-beam cure with minimal facility and shielding requirements.
- **C-C Control Surface Mod.**
  - Eliminates requirement for TPS which reduces weight, and reduces operation and maintenance requirements.
- **PMC Damage Tolerance**
  - Extend current database for life/thermal issues and develop repair methods for PMC's.
- **CMC Life Prediction**
  - Enable better initial designs, faster redesigns and reduce test requirements.

Current Technology Tasks

Vehicle Systems (TA1-Continued)

Thermal Protection System

- **High Temperature Felt TPS**
  - Increase the temperature capability of the current felt TPS to 1500F to enable greater use for vehicle acreage.
- **Advanced High Temperature Structural Seals**
  - Develop TPS seals that are more reliable and reduce maintenance cost.
- **Ultra-High Temperature Leading Edges**
  - Provide an in-depth trade study of active vs. passive (UHTC) leading edges for a sharp body lifting vehicle. Extend present design tools to include real chemistry effects and pressure dependence in the aerothermal performance constraints. Resume the development of advanced UHTCs, including new composites, alloys, and continuous fiber reinforced ceramic composites
- **Subsurface Microsensors for Assisted Recertification of TPS**
  - Consists of wireless microchips embedded in the vehicle TPS. Uses existing state-of the-art, wireless microchip technologies with an optimized sensor suite, which could include temperature probes, strain gauges, charring detectors, pressure sensors, etc. An automated RF transmitter would be used to remotely power the onboard microsensors, query location and sensor status.

Current Technology Tasks

Propulsion Systems (TA2)

- **Adv. Fuels Tech Demo in a AR2-3 Rocket Engine**
  - H2O2 and RP propellants to update the existing database on these fuels and provide validated foundation for upper-stage development effort.
- **Closed-Coupled Jet Pump/Inducer Design**
  - Would potentially replace expensive rotating components with non-moving jet pump to reduce weight and increase operability/reliability and improved deep throttling performance.
- **Liq Azide Fuel Development**
  - LOX/liquid azide bipropellant would replace LOX/RP-1 bipropellant and increase the specific impulse by 4-6 seconds. The liquid azide fuel is 16% more dense than RP-1. The liquid azide fuel could be used for TVC/RCS since it is a suitable monopropellant and has been shown to have as much performance as hydrazine while being less toxic.
- **CMC Nozzle for Upper Stage Applications**
  - Develop low cost designs and manufacturing processes for CMC nozzles that could be applied to both boost and upper-stage engines to eliminate or greatly reduce cooling requirements for the nozzles.

NRA8-21 Cycle 2 Overview

Key NRA Contacts

- **Selection Official**
  - Rick Bachtel, NASA MSFC
- **Procurement Lead**
  - Mark Stiles, NASA MSFC
- **Small Payload Reusable Launch System Manager**
  - Sherry Buschmann, NASA MSFC

Overview

- The scope of this activity includes advanced operations technologies, peroxide-based propulsion technologies, long life reusable boost technologies and any other core reusable technology that would result in a significant reduction in space transportation cost
- Limited to technology development and demonstrations that support low cost reusable transportation systems
- NRA allows for technologies that support a low cost expendable orbital transfer system when used in conjunction with other reusable transportation systems
- System payoffs/customers must be defined for all activities
- Activities must be product focused (not paper studies)
- Opportunities open to industry / academia / government laboratories

NRA Scope

Advanced Operations Focused Technologies

- **Significantly reduces the cost of flight and ground operations**
  - Capability for remote/automated vehicle safing
  - Automated pre-flight testing and inspection, reduced and/or automated servicing
  - Automated mission planning

Peroxide Based Propulsion Focused Technologies

- **Offers potential for satisfying need for very low cost upper stage for both Small Payload Launch Systems and Military Space Plane Architectures**
  - Advanced materials and technologies to reduce system weight, increase combustion efficiencies, and to lower cost of delivered stages
  - Innovative applications of peroxide systems for airbreathing propulsion systems

Long Life Booster Focused Technologies

- **Propulsion technologies that lower engine weight and/or improve engine performance**
  - Advanced materials and processes to improve specific strength, increase temperature capability, or otherwise improve engine thrust to weight ratio

Airframe/Vehicle systems (TA-1)

Examples:

- Ground and payload operations
- Cryogenic tanks
- Structures and materials
- Thermal protection systems
- Integrated health management systems
- Avionics and power
- Guidance, navigation and control
- Flight and mission operations
- Analytical and design tools

NRA Technology Areas (cont'd)

Propulsion systems (TA-2)

Examples:

- Engine Operability
- Main engine systems, components and subsystems
- Propellants
- Lines, ducts and valves
- High temperature materials
- Lightweight materials
- Auxiliary propulsion components and subsystems (e.g., RCS, OMS)
- Propulsion related health management systems
- Analytical and design tools

Other Related Technologies (TA-3)

Available Budget (Planning Only)

$M	FY99	FY00	FY01	Total
Cycle II				
Focused & Core	$2.0	$3.0	$3.0	**$8.0**
Total	**$2.0**	**$3.0**	**$3.0**	**$8.0**

- **Funding provided directly to offerors**
- **Funds required to pay for charges relating to the performance of Government responsibilities under resulting grants, cooperative agreements or contracts**

Schedule

Cycle 2 Proposals Due	April 15
Cycle 2 Negotiations (@ MSFC)	May 10 – May 24
Cycle 2 Award	June 1

Proposal Instructions

Potential Award Instruments

- **Multiple awards are anticipated**

- **Several instruments may be used to execute this NRA:**
  - Contracts

    All awards will be performance-based.

    No cost-plus-fixed-fee contracts will be awarded as a result of this NRA.
  - Grants
  - Cooperative Agreements

- **<u>Y2K Compliance is Required</u>**

Cooperative Agreement Cost Sharing

NASA Contribution

- **Funds provided to Industry Partner**
- **Funds provided to Government Installations for Support Tasks**

Industry Contribution

- **Funds provided by Industry**
  - Cash, IRAD, In-Kind

NASA Cooperative Agreement Policy Requires a 50:50 Ratio

Proposal Instructions - Mechanics

- **Each offeror is encouraged to submit separate proposals for each stand-alone task or technology area**

- **Page count: limited to 25 pages (excluding transmittal letter, table of contents, task agreements, and supporting cost data)**
  - See NRA for details

- **Submit an electronic version in Word / Excel on a Zip or Jaz**

Proposal Instructions - Technical

- **Provide a technology development and insertion roadmap**
- **Within each Technology Area, offerors shall submit stand alone tasks**
- **Prioritize tasks across and within Technology Areas**
- **Provide for EACH TASK proposed under a technology area:**
  - **Identification of scope area:** Operations, Peroxide Propulsion, Long Life Booster Focused Technology, or other Core Reusable Technology Description of the responsibilities and tasks to be accomplished
  - Identification of potential customers for the technology
  - Identification of potential operational system payoffs from incorporation of the technology.
  - Technical approach for all appropriate disciplines
  - Test plan for all major tests
  - Integrated task schedule including milestones, key products and off-ramps
  - Plans for defining, measuring, evaluating, and reporting progress toward success over the course of the task (measured annually).
  - Major challenges to maturing the technology
  - A task cost breakdown

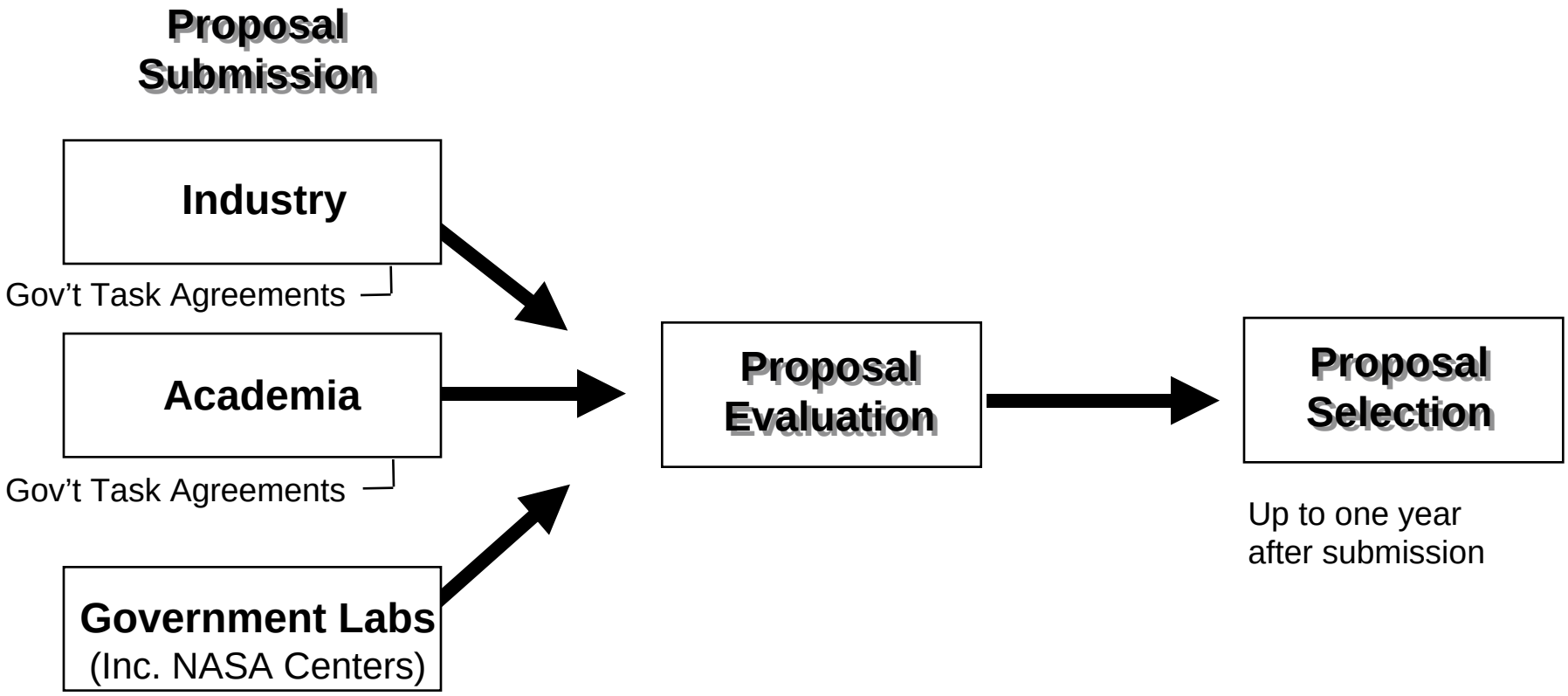
Government Laboratory Support

- **Substantial involvement by Government Laboratories is required by policy for cooperative agreements**
- **Government installations are available to all offerors to support technology development**
  - Personnel, facilities, etc.
- **Letter of Commitment from Installation Director or designee is required**
- **Support task funding requirements must be reimbursed out of the NRA 8-21 budget**
  - Includes any required civil service overhead charges, facility modifications, facility use, support contractors, etc. set by each center
  - NRA funds may not be used to cover the full cost of civil servant labor or travel
  - All reimbursements will be made internal to the Government
- **Proposals will not be evaluated on the amount of tasks they make available to Government installations**

Government Installation Points of Contact

Ames Research Center (ARC)	Dan Bencze
Dryden Flight Research Center (DFRC)	John Hicks
Jet Propulsion Laboratory (JPL)	Ken Russ
Johnson Space Center (JSC)	Harry Erwin
Kennedy Space Center (KSC)	Warren Wiley
Langley Research Center (LaRC)	Sharon Welch
Lewis Research Center (LeRC)	Scott Graham
Marshall Space Flight Center (MSFC)	Steve Stoyanof
Stennis Space Center (SSC)	Patrick Scheuermann
USAF Research Laboratory	Capt. John Anttonen

Selection Process



Blackout Conditions Exist After Receipt of Proposals and During Selection Process

Evaluation Factors

- **Relevance to NASA's objectives**
  - Traceability of the technology to future space transportation needs, including the potential system payoffs (including cost reduction and performance improvement) to future systems.
  - Applicability of the technology to a broad range of future space transportation needs
  - Propulsion related technologies must show contribution to meeting Integrated High Payoff Rocket Propulsion Technology Program (IHPRPT) goals in Appendix F of NRA8-21
  - Restrictions on technology produced
  - Deviations to the model Cooperative Agreement (if applicable)
- **Intrinsic merit**
  - Technical merit, unique and innovative methods / approaches / concepts
  - Offeror's capabilities, experience (past performance), facilities, techniques
  - Key personnel qualifications, capabilities and experience
  - Standing among similar proposals and/or evaluation against the state-of-the-art
- **Cost**
  - Realism and reasonableness

Negotiations with Selected Offerors

- **Teams selected for negotiations will be notified after source evaluation committee briefs the source selection official**
- **All or part of a proposal may be selected for negotiations**
- **Negotiations will be conducted in parallel with multiple offerors**
- **Industry / academia teams should bring appropriate technical and procurement staff to MSFC for negotiations**
  - All negotiations will be completed within two weeks at MSFC
  - Plan to SIGN instruments with offerors at MSFC

NASA Policy on Foreign Participation

- Foreign participation must provide clear net benefits to the achievement of the program's technical and business objectives.
- Federal funds may be used for manufacture or acquisition of flight-ready foreign component technology, but may not be used for foreign-based development of foreign technology, unless specifically exempted by the NASA Administrator.
- Incorporation of foreign technology must not threaten the successful execution of the program, both in its developmental and operational phases.
- Due consideration is given to fostering U.S. competitiveness and safeguarding national security interests throughout the life of the program.
- Close consultation is maintained with NASA and other appropriate U.S. Government agencies on all aspects of foreign participation.

Other Information

- **Internet location of documents:**
  - NRA 8-21and Offerors Briefing:

    http://nais.msfc.nasa.gov

- **Breakout rooms available today (signup posted outside rooms)**
  - 4202 / Room 103 10:30 - 2:30PM
  - 4202 / Room 530 12:00 - 4:00PM

Cycle 2 Proposals Due On April 15, 1999